What is claimed is:

1 A base-station cell design method adapted so that, in cell designing base-station installment in a mobile communication system, a plurality of base-station candidate locations are given within a service area to locate base station in anyone of these base-station candidate locations, said base-station cell design method comprising the steps of:

an objective-function calculation step of calculating a predetermined objective-function responding to a traffic absorption quantity and (or) a communication quality value of said base-station candidate locations; and

a base-station layout decision step of deciding a layout at which the base station is installed responding to this objective-function.

2 The base-station cell design method according to claim 1, said base-station cell design method characterized in being adapted so that:

in said objective-function calculation step, the higher said quantity and (or) quality are, the higher objective-function is given; and

in said base-station layout decision step, a location of which said objective-function is highest is decided.

3 The base-station cell design method according to claim 1, said base-station cell design method characterized in that said objective-function is given as a function of the base-station candidate location, the channel, a kind of antennas to be used, and its installment direction.

4 The base-station cell design method according to claim 1, said base-station cell design method characterized in being adapted so that said objective-function calculation steps are performed in parallel.

5 A base-station cell design method adapted so that, in cell designing in a mobile communication system, a plurality of base-station candidate locations are given within a service area to decide anyone of these base-station candidate locations as a base-station layout while a radio-wave propagation characteristic estimation technique is used, said base-station cell design method comprising the steps of:

as a radio-wave propagation characteristic estimation technique within said service area with each of said base-station candidate locations taken as a transmission point, using a first radio-wave propagation characteristic

estimation technique having a first precision; and

as a radio-wave propagation characteristic estimation technique within said service area with a base-station location after a case where said base station was decided taken as a transmission point, using a second radio-wave propagation characteristic estimation technique having a precision higher than said first precision.

6 The base-station cell design method according to claim 5, said base-station cell design method characterized in:

as said first radio-wave propagation characteristic estimation technique, employing a technique that an electric power attenuates in proportional to an exponential power of a distance; and

as said second radio-wave propagation characteristic estimation technique, employing a ray tracing technique.

7 A base-station cell design method in a mobile communication system, wherein a service area, and a traffic density distribution within this service area are given to locate base stations within the above service area, said base-station cell design method characterized in including a base-station layout decision step of sequentially deciding until traffic coverage ratio exceeds

desired traffic coverage ratio and said traffic coverage ratio is defined as a rate of a total traffic quantity absorbed by the base stations to all the traffic quantity that occurs within said service area.

8 The base-station cell design method according to claim 7, said base-station cell design method characterized in that said base-station layout decision step comprises:

a step of calculating a traffic absorption quantity and (or) a communication quality value in each of candidate locations of said base station;

an objective-function calculation step of calculating a predetermined objective-function responding to the quantity and (or) the value that are this calculated result; and

a step of selecting a layout at which the base station is installed responding to this objective-function.

9 The base-station cell design method according to claim 8, said base-station cell design method characterized in being adapted so that:

in said objective-function calculation step, the higher said quantity and (or) quality are, the higher objective-function is given; and

in said step of selecting the layout at which the base station is located, the base station is located in the location of which said objective-function is highest.

10 The base-station cell design method according to claim 9, said base-station cell design method characterized in being adapted so that:

a first radio-wave propagation characteristic estimation technique having a first estimation precision is employed for estimating a radio-wave propagation characteristic within said service area for the candidate location of base station taken as a transmission point; and

a second radio-wave propagation characteristic estimation technique having an estimation precision higher than said first estimation precision is employed for estimating a radio-wave propagation characteristic within said service area for the decided location of base station taken as a transmission point.

11 The base-station cell design method according to claim 10, said base-station cell design method characterized in further including a deletion step of sequentially deleting said base stations which was decided until said traffic coverage ratio Rc satisfies a desired

traffic coverage ratio Rth.

12 The base-station cell design method according to claim 11, said base-station cell design method characterized in, in said deletion step, calculating a modified traffic coverage ratio Rm without each of the located base stations to find the base station of which a difference between this Rm and said traffic coverage ratio Rc becomes minimum, and in the case that the modified traffic coverage ratio Rm in a case where this base station was deleted satisfies said Rth, to delete the above base station.

13 The base-station cell design method according to claim 11, said base-station cell design method characterized in, in said deletion step, calculating said objective-function in a case where each of the base stations was deleted, with the base station without which the above objective-function becomes maximum at the time that it was deleted taken as a candidate for deletion, to find a modified traffic coverage ratio Rm in a case where this candidate for deletion was deleted, and in the case that this Rm satisfies said Rth, to delete said candidate for deletion.

14 The base-station cell design method according to claim 10, said base-station cell design method characterized in:

setting a covered area shape to be computed by said first radio-wave propagation characteristic estimation technique, or a fixed shape as an area shape that an bases station candidate covers; and

setting a covered area shape to be computed with an estimation result estimated and stored by said second radio-wave propagation characteristic estimation technique as an area shape that the located base station.

15 The base-station cell design method according to claim 14, said base-station cell design method characterized in that, an covered area shape for located base station and candidate base station is set based on the area where each observation point within area received desired quality signals and selects a belonging base station with the observation point receives the highest received quality and power of all base stations.

16 The base-station cell design method according to claim 14, said base-station cell design method characterized in that,

an covered area shape for located base station and

candidate base station is set based on the area where total traffic quality is below the traffic capacity of the base station as an area shape that said base station for which installment was decided and said base-station candidate cover respectively, is set an area such that a total of the traffic quantity within the above area falls below the traffic quantity that the base station can accommodate.

17 The base-station cell design method according to claim 10, said base-station cell design method characterized in, by taking into consideration a transmitted electric power of said base station for which installment was decided, and a determination threshold as well in a received demodulation processing in the above base station, in addition to the estimation result estimated by said second radio-wave propagation characteristic estimation technique, deciding said area shape.

18 The base-station cell design method according to claim 10, said base-station cell design method characterized in being adapted so that, in allocating a channel to said base station for which installment was decided within said service area, said objective-function

is calculated for all channels with a radio-wave propagation characteristic estimated by said second radio-wave propagation characteristic estimation technique to allocate the channel of which the objective-function becomes maximum.

19 The base-station cell design method according to claim 8, said base-station cell design method characterized in, as said traffic absorption quantity, employing a traffic quantity that occurs within an area to be covered by a base-station candidate to be computed by said traffic density distribution, or a rate of this traffic quantity to a total traffic quantity that occurs within said service area.

20 The base-station cell design method according to claim 8, said base-station cell design method characterized in, as said traffic absorption quantity, employing a traffic quantity that occurs within the area other than the area covered by the base station for which installment was decided, out of the areas to be covered by the base-station candidate to be computed by said traffic density distribution, or a ratio of this traffic quantity to a total traffic quantity that occurs within said service area.

21 The base-station cell design method according to claim 8, said base-station cell design method characterized in, as said traffic absorption quantity, employing a total traffic quantity that occurs in all the area to be covered by the base station for which installment was decided and the base-station candidate, or a ratio of this total traffic quantity to a total traffic quantity that occurs within said service area.

22 The base-station cell design method according to claim 8, said base-station cell design method characterized in that, as said quality value, are given a desired received signal power/(an undesired received signal power + a noise signal power), the desired received signal power/the undesired received signal power, a bit error ratio, a frame error ration.

23 The base-station cell design method according to claim 8, said base-station cell design method characterized in:

as said quality value, employing a sum total of interference quantities from the base stations for which installment was decided, said interference quantity being observed in the base-station candidate location;

in computing the interference quantity from the already-installed base station, employing a propagation-loss estimation result computed and stored by said second radio-wave propagation characteristic estimation technique; and

deciding said quality value so that the smaller the sum total of said interference quantity is, the higher the quality value becomes.

24 The base-station cell design method according to claim 8, said base-station cell design method characterized in, as said quality value, employing an average of a ratio of a desired-signal electric power: an undesired-signal electric power that a terminal within the area that the additional base-station candidate covers observes to exclude a location within the above covered area in which no traffic occurs in averaging it.

25 The base-station cell design method according to claim 8, said base-station cell design method characterized in, as said quality value, employing an average of a ratio of a desired-signal electric power: an undesired-signal electric power that a terminal observes within the entire region of the service area to exclude a location in which no traffic occurs within the above

covered area in averaging it.

26 The base-station cell design method according to claim 8, said base-station cell design method characterized in, as said quality value, employing a rate, which satisfies a desired ratio of a desired-signal electric power: an undesired-signal electric power, out of ratios of the desired-signal electric power: the undesired-signal electric power that a terminal observes in the entire service area.

27 The base-station cell design method according to claim 8, said base-station cell design method characterized in assuming a transmitted power of the base station for which installment was decided or the base-station candidate to be a fixed value, said transmitted power being referred to in computing said quality value.

28 The base-station cell design method according to claim 8, said base-station cell design method characterized in deciding a transmitted power of the base station for which installment was decided or the base-station candidate with the traffic quantity to be absorbed by the above base station, said transmitted power being referred to in computing said quality value.

29 The base-station cell design method according to claim 8, said base-station cell design method characterized in:

as said first radio-wave propagation characteristic estimation technique, employing a technique that an electric power attenuates in proportional to an exponential power of a distance; and

as said second radio-wave propagation characteristic estimation technique, employing a ray tracing technique.

30 The base-station cell design method according to one of claim 7, said base-station cell design method characterized in that no location within the service area in which no traffic occurs is included in said candidate location.

31 The base-station cell design method according to claim 7, said base-station cell design method characterized in that no location in which the base station is physically impossible to arrange is included in said candidate location.

32 The base-station cell design method according to claim 10, said base-station cell design method

characterized in that said candidate location is seasoned with information relating to a direction of the base station as well for decision.

33 The base-station cell design method according to claim 10, said base-station cell design method characterized in, in the event that said candidate location was pre-given a priority, as said objective-function, using a new objective-function having the above priority considered for this objective-function.

34 The base-station cell design method according to claim 10, said base-station cell design method characterized in being adapted so that said objective-function is varied in the event that said objective-function has an identical value in the different candidate locations or channels as well.

35 The base-station cell design method according to claim 7, said base-station cell design method characterized in:

with regard to a first service area, executing said base-station layout decision step; and

afterward, with regard to a second service area that is partially overlapped with said first service area,

executing said base-station installment step for the base-station candidate location other than the base station for which installment was decided in said first service area.

36 The base-station cell design method according to claim 8, said base-station cell design method characterized in that said objective-function is given as a function of the base-station candidate location, the channel, a kind of antennas to be used, and its installment direction.

37 The base-station cell design method according to claim 8, said base-station cell design method characterized in being adapted so that said objective-function calculation steps are performed in parallel.

38 A base-station cell design apparatus adapted so that, in designing a base-station installment in a mobile communication system, a plurality of base-station candidate locations are given within a service area to install a base station in anyone of these base-station candidate locations, said base-station cell design apparatus characterized in including:

objective-function calculation means for calculating a predetermined objective-function responding to a traffic

absorption quantity and/or a communication quality value in each of said base-station candidate locations; and

base-station layout decision means for deciding a layout at which the base station is installed responding to this objective-function.

39 The base-station cell design apparatus according to claim 38, said base-station cell design apparatus characterized in that said objective-function is given as a function of the base-station candidate location, the channel, a kind of antennas to be used, and its installment direction.

40 A base-station cell design apparatus adapted so that, in designing a base-station installment in a mobile communication system, a plurality of base-station candidate locations are given within a service area to decide anyone of these base-station candidate locations as a base-station installment layout while a radio-wave propagation characteristic estimation technique is used, said base-station cell design apparatus characterized in including the means for:

as a radio-wave propagation characteristic estimation technique within said service area with each of said base-station candidate locations taken as a transmission point,

using a first radio-wave propagation characteristic estimation technique having a first precision to install said base station; and

as a radio-wave propagation characteristic estimation technique within said service area with a base-station installment location after a case where said base station was installed taken as a transmission point, using a second radio-wave propagation characteristic estimation technique having a precision higher than said first precision.

41 A base-station cell design apparatus in a mobile communication system, wherein a service area, and a traffic density distribution within this service area are given to arrange a base station within the above service area, said base-station cell design apparatus characterized in including base-station layout decision means for, with a rate of a total traffic quantity that can be absorbed by the base station arranged within said service area to all the traffic quantity that occurs within said service area taken as a traffic coverage ratio, sequentially deciding layouts at which the base station is installed until said traffic coverage ratio exceeds a desired traffic coverage ratio.

42 The base-station cell design apparatus according to claim 41, said base-station cell design apparatus characterized in further including deletion base-station decision means for sequentially deleting said base stations for which installment was decided until said traffic coverage ratio satisfies a desired traffic coverage ratio.

43 A computer-readable program for causing a computer to execute a base-station cell design method adapted so that, in designing a base-station installment in a mobile communication system, a plurality of base-station candidate locations are given within a service area to install a base station in anyone of these base-station candidate locations, said program characterized in comprising:

an objective-function calculation step of calculating a predetermined objective-function responding to a traffic absorption quantity and (or) a communication quality value in each of said base-station candidate locations; and

a base-station layout decision step for deciding a layout at which the base station is installed responding to this objective-function.

44 The program according to claim 43, said program

characterized in being adapted so that:

in said objective-function calculation step, the higher said quantity and (or) value are, the higher objective-function is given; and

in said base-station layout decision step, the location of which said objective-function is highest is decided.

45 The program according to claim 43, said program characterized in that said objective-function is given as a function of the base-station candidate location, the channel, a kind of antennas to be used, and its installment direction.

46 The program according to claim 43, said program characterized in being adapted so that said objective-function calculation steps are performed in parallel.

47 A computer-readable program for causing a computer to execute a base-station cell design method adapted so that, in designing a base-station installment in a mobile communication system, a plurality of base-station candidate locations are given within a service area to decide anyone of these base-station candidate locations as a base-station installment layout while a radio-wave

propagation characteristic estimation technique is used, said program characterized in comprising the steps of:

as a radio-wave propagation characteristic estimation technique within said service area with each of said base-station candidate locations taken as a transmission point, using a first radio-wave propagation characteristic estimation technique having a first precision to additionally install said base station; and

as a radio-wave propagation characteristic estimation technique within said service area with said base-station additional-installment location after a case where said base station was installed taken as a transmission point, using a second radio-wave propagation characteristic estimation technique having a precision higher than said first precision.

48 A computer-readable program for causing a computer to execute a base-station cell design method in a mobile communication system, wherein a service area, and a traffic density distribution within this service area are given to arrange a base station within the above service area, said program characterized in including a base-station layout decision step of, with a rate of a total traffic quantity that can be absorbed by the base stations arranged within said service area to all traffic quantity

that occurs within said service area taken as a traffic coverage ratio, sequentially deciding layouts at which the base station is installed until said traffic coverage ratio exceeds a desired traffic coverage ratio.

49 The program according to claim 48, said program characterized in that said base-station layout decision step including:

a step of calculating a traffic absorption quantity and (or) a communication quality value in each of said base-station candidate locations;

an objective-function calculation step of calculating a predetermined objective-function responding to the quantity and (or) the value that are this calculated result; and

a step of selecting the layout at which the base station is installed responding to this objective-function.

50 The program according to claim 49, said program characterized in being adapted so that:

in said objective-function calculation step, the higher said quantity and (or) value are, the higher objective-function is given; and

in said step of selecting the layout at which the base station is installed, the location of which said

objective-function is highest is decided.

51 The program according to claim 50, said program characterized in being adapted so that:

a first radio-wave propagation characteristic estimation technique having a first estimation precision is employed for estimating a radio-wave propagation characteristic within said service area with the candidate location in which said base station is installed taken as a transmission point; and

a second radio-wave propagation characteristic estimation technique having an estimation precision higher than said first estimation precision is employed for estimating a radio-wave propagation characteristic within said service area with the above base station after a case where said base station was installed taken as a transmission point.

52 The program according to claim 51, said program characterized in further including a deletion step of sequentially deleting said base stations for which installment was decided until said traffic coverage ratio satisfies a desired traffic coverage ratio.

53 The program according to claim 52, said program

characterized in, in said deletion step, finding a modified traffic coverage ratio Rm in a case where each of base stations for which installment was decided was deleted to find the base station of which a difference between this Rm and said traffic coverage ratio Rc becomes minimum, and in the event that the modified traffic coverage ratio Rm in a case where this base station was deleted satisfies said Rth, to delete the above base station.

54 The program according to claim 52, said program characterized in, in said deletion step, calculating said objective-function in a case where each of base stations for which installment was decided was deleted, with the base station of which the above objective-function becomes maximum at the time that it was deleted taken as a candidate for deletion, to find a modified traffic coverage ratio Rm in a case where this candidate for deletion was deleted, and in the event that this Rm satisfies said Rth, to delete said base station.

55 The program according to claim 51, said program characterized in:

as an area shape that an additional base-station candidate covers, setting a shape to be computed by said

first radio-wave propagation characteristic estimation technique, or a fixed shape, and

as an area shape that the base station for which installment was decided covers, setting a shape to be computed with an estimation result estimated and stored by said second radio-wave propagation characteristic estimation technique.

56 The program according to claim 55, said program characterized in that, as an area shape that the base station for which installment was decided and said base-station candidate cover respectively, is set an area such that a connection to the base station, which satisfies a desired received quality within each covered area, and yet of which a received quality or a received electric power is highest becomes possible.

57 The program according to claim 56, said program characterized in that, as an area shape that the base station for which installment was decided, and said base-station candidate cover respectively, is set an area such that a total of the traffic quantity within the above area falls below the traffic quantity that the base station can accommodate.

58 The program according to claim 52, said program characterized in, in addition to the estimation result estimated by said second radio-wave propagation characteristic estimation technique, by taking into consideration a transmitted electric power of said base station for which installment was decided, and a determination threshold in a received demodulation processing in the above base station as well, deciding said area shape.

59 The program according to claim 52, said program characterized in being adapted so that, in allocating a channel to said base station for which installment was decided within said service area, said objective-function is calculated for all channels with a radio-wave propagation characteristic estimated by said second radio-wave propagation characteristic estimation technique to allocate a channel of which the objective-function becomes maximum hereto.

60 The program according to claim 55, said program characterized in, as said traffic absorption quantity, employing a traffic quantity that occurs within the area to be covered by the base-station candidate to be calculated by said traffic density distribution, or a rate

of this traffic quantity to a total traffic quantity that occurs within said service area.

61 The program according to claim 55, said program characterized in, as said traffic absorption quantity, employing a traffic quantity that occurs in the area other than the area covered by the base station for which installment was decided, out of the areas to be covered by the base-station candidate to be computed by said traffic density distribution, or a rate of this traffic quantity to a total traffic quantity that occurs within said service area.

62 The program according to claim 55, said program characterized in, as said traffic absorption quantity, employing a total traffic quantity that occurs in all the area to be covered by the additional base station for which installment was decided, and the base-station candidate, or a rate of this total traffic quantity to a total traffic quantity that occurs within said service area.

63 The program according to claim 55, said program characterized in that, as said quality value, are given a desired received signal power/(a undesired received signal

power + a noise signal power), the desired received signal power/the undesired received signal power, a bit error ratio, a frame error ration.

64 The program according to claim 55, said program characterized in: as said quality value, employing a sum total of interference quantities from the base station for which installment was decided, said interference quantity being observed in the base-station candidate location;

in computing the interference quantity from the already-installed base station, employing a propagation-loss estimation result computed and stored by said second radio-wave propagation characteristic estimation technique; and

deciding said quality value so that the smaller said sum total of said interference quantity is, the higher the quality value becomes.

65 The program according to one of claim 55, said program characterized in, as said quality value, employing an average of a ratio of a desired-signal electric power: an undesired-signal electric power that a terminal within the area that the additional base-station candidate covers observes to exclude a location within the above covered area in which no traffic occurs in averaging it.

66 The program according to claim 55, said program characterized in, as said quality value, employing an average of a ratio of a desired-signal electric power: an undesired-signal electric power that a terminal observes within the entire service area to exclude a location within the above service area in which no traffic occurs in averaging it.

67 The program according to claim 55,said program characterized in, as said quality value, employing a rate that satisfies a desired ratio of a desired-signal electric power: an undesired-signal electric power, out of the ratios of the desired-signal electric power: the undesired-signal electric power that a terminal observes in the entire service area.

68 The program according to claim 64, said program characterized in assuming a transmitted power of the base station for which installment was decided, or the base-station candidate to be a fixed value, said transmitted power being referred to in computing said quality value.

69 The program according to claim 64, said program characterized in deciding a transmitted power of the base

station for which installment was decided, or the base-station candidate with the traffic quantity to be absorbed by the above base station, said transmitted power being referred to in computing said quality value.

70 The program according to claim 47, said program characterized in:

as said first radio-wave propagation characteristic estimation technique, employing a technique that an electric power attenuates in proportional to an exponential power of a distance; and

as said second radio-wave propagation characteristic estimation technique, employing a ray tracing technique.

71 The program according to claim 48, said program characterized in:

as said first radio-wave propagation characteristic estimation technique, employing a technique that an electric power attenuates in proportional to an exponential power of a distance; and

as said second radio-wave propagation characteristic estimation technique, employing a ray tracing technique.

72 The program according to claim 48, said program characterized in that no location within the service area

in which no traffic occurs is included in said candidate location.

73 The program according to claim 48, said program characterized in that no location in which the base station is physically impossible to arrange is included in said candidate location.

74 The program according to claim 48, said program characterized in that said candidate location is seasoned with information relating to a direction of the base station as well for setting.

75 The program according to claim 48, said program characterized in, in the event that said candidate location was pre-given priority, as said objective-function, using a new objective-function having the above priority considered for this objective-function.

76 The program according to claim 50, said program characterized in being adapted so that said objective-function is varied in the event that said objective-function has an identical value in different candidate locations or channels as well.

77 The program according to claim 48, said program characterized in:

with regard to a first service area, executing said base-station layout decision step; and

afterward, with regard to a second service area that is partially overlapped with said first service area, executing the above base-station layout decision step for the base-station candidate location other than the base station candidate location for which installment was decided in said first service area.

78 The program according to claim 49, said program characterized in that said objective-function is given as a function of the base-station candidate location, the channel, a kind of antennas to be used, and its installment direction.

79 The program according to claim 49, said program characterized in being adapted so that said objective-function calculation steps are performed in parallel.

80 A base-station design method in a mobile communication system, said base-station design method characterized in including:

a step of giving a plurality of base-station candidate

locations within a service area; and

an objective-function calculation step of, with a predetermined objective-function, calculating at least one of a traffic absorption quantity and a communication quality value in a case where a base station was installed in anyone of said base-station candidate locations.

81 A base-station cell design method in a mobile communication system, said base-station cell design method characterized in including:

a base-station candidate location setting step of giving a plurality of base-station candidate locations within a service area;

an objective-function calculation step of, with a predetermined objective-function, calculating at least one of a traffic absorption quantity and a communication quality value in a case where a base station was installed in each of said base-station candidate locations; and

a step of employing a result of the objective-function calculated in said objective-function calculation step to decide a base-station installment location within said service area.

82 A base-station cell design method of, in designing a base-station installment in a mobile communication system,

designing parameters to be set for base stations given in plural within a service area, said base-station cell design method characterized in including:

an objective-function calculation step of calculating a predetermined objective-function responding to a traffic absorption quantity and (or) a communication quality value in each of said base stations; and

a base-station parameter decision step of deciding parameters for installing the base station responding to this objective-function.

83 A base-station cell design apparatus for, in designing a base-station installment in a mobile communication system, designing parameters to be set for base station given in plural within a service area, said base-station cell design apparatus characterized in including:

objective-function calculation means for calculating a predetermined objective-function responding to a traffic absorption quantity and (or) a communication quality value in each of said base stations; and

base-station parameter decision means for deciding parameters for installing the base station responding to this objective-function.

84 A computer-readable program for causing a computer to execute a base-station cell design method of, in designing a base-station installment in a mobile communication system, designing parameters to be set for base station given in plural within a service area, said program characterized in including:

an objective-function calculation step of calculating a predetermined objective-function responding to a traffic absorption quantity and (or) a communication quality value in each of said base stations; and

a base-station parameter decision step of deciding parameters for installing the base station responding to this objective-function.